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fig: 2.

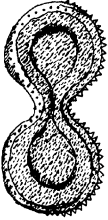


fig: 4.

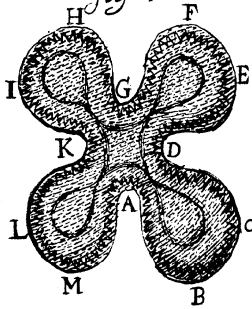


fig: 10.

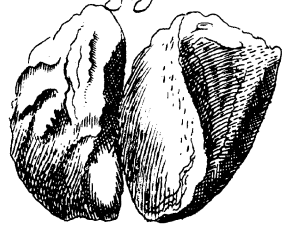


fig: 1.



fig: 3.

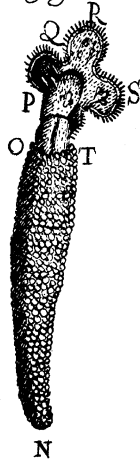


fig: 8.



fig: 5.



fig: 7.

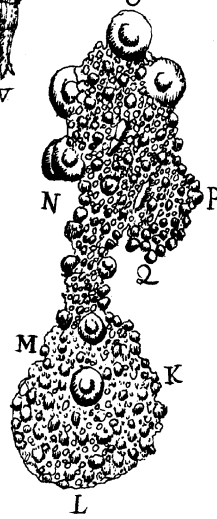
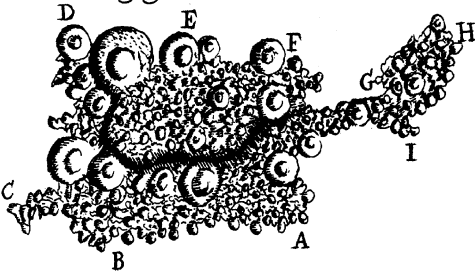


fig: 6.



I. *A Letter to the Royal Society, from Mr Anthony Van Leeuwenhock, F. R. S. concerning Animalcula on the Roots of Duck-weed, &c.*

YOU may remember, that in my Letter of the 25th of Decemb. 1702. I affirm'd that the Animalcula, represented by Fig. 8. a. b. c. that were fastned to the small Roots of that Green stuff found on the top of the Water in our Ditches and little Canals, which we call Duck-weeds, had two small Wheels issuing out of their Bodies.

A certain Curious Gentleman, that saw the Motion of these Wheels with great satisfaction, entreated me, that when I had an opportunity, I would once again show him this Wonderful Rotation.

In the Month of July last, I caused several of these Weeds, as they were carried by the Stream thro' our Town, be taken out of the Water in an Earthen Pot, and took my full view of the foremention'd Animalcula at several times, which appear'd as here in Fig. 1. A B C D E F G. The Case or Sheath of which is represented by A B G, into which the Animalculum betakes itself, upon the least shaking or stirring of the Duck-weed, and then thrusts itself out again as far as B C F G, and at the same time appear the two little Wheels described by C D E F, in observing the Motion of which one would be apt to think they were two real Revolving Wheels.

But so soon as we were able to place the Animalculum before our Eyes, in such a position that we could view the little Wheels, not partially, as is here represented, but compleatly, and all at once, we were convinced of
our

our Mistake in our former Assertions ; for now we saw clearly that what appear'd before to be two distinct little Wheels, was really one and the same Circumvolution.

Now, in order, to give you a clearer Notion of the two described Wheels, I order'd the Painter to draw 'em larger than they appear'd to his sight.

Fig. 2. H I K L M represents the said Wheels, in which the Rotation proceeds from H to I, and so on from I to K, and from K to L M.

I have often stood in suspense whether this Regular and Wonderful Rotation did really happen as it appeared to me, and several other Gentlemen that saw it ; yet I could not chuse but be satisfy'd at last of the *Phenomenon*, forasmuch as having, in order to my entire satisfaction, thrown away those Wheels (to the Roots of which the said Animalcula cleaved) and made my Observations on several others, I found the same event every time, only with this difference, that the internal Arches in Fig. 2. described by K and M, were not near so much Indented.

During those Observations, one Animalculum appear'd to me, as in Fig. 3. N O P Q R S T, and N, that part of it by which it was fastned to the Weed.

This Animalculum had his Receptacle or little House (represented by N O T) composed of Round Bubbles, which Figure had not occur'd to me before.

When this Animalculum had thrust that part of its Body, from O to P, out of its Case or Shell, it produced out of its own Body at the same time that Wonderful Wheel-work that consisted of four round parts, represented in Fig. 3. by P Q R S, three of which were to be seen very plain, but the fourth at T was almost hid from the sight.

All this Wheel-work moved from P to Q, and from R to S.

After

After I had nicely observed the said *Animalculum*, I directed the Painter to draw the same as well as he could, according to its appearance in Fig. 3.

After some little time this *Animalculum* appear'd in such a position that we could compleatly see all the four parts, whereupon I order'd my Painter to describe the Rotation with a larger Circumference than it really appear'd, to the end that you may the better understand this wonderful and unconceivable Wheel-work with all its Teeth.

Fig. 4. A B C D E F G H I K L M represents that Instrument that in Fig. 3. is for the most part of it describ'd by P Q R S, in which we saw the said Teeth and Wheel-work move from A B C to D, and from D to E F G, and after that manner perform the whole Revolution; and forasmuch as I had placed the said Delightful *Animalculum* just as it was fastned to the Root of the Weed in the Water, before my Microscope, I took that opportunity to communicate a view of it to two several Gentlemen, who were struck with the greatest Amazement at the sight of such an inconceivable Rotation; and at the least sudden touch of the *Animalculum*, it presently drew the Wheel-work into its Body, and then its whole Body into its Case or Shell, so that we could see nothing but a kind of Horn, Fig. 3. N O T, in which it hid itself; but it quickly put forth that part of its Body describ'd by O P Q R S T, and then the Rotation or Wheel-work proceeded as before.

Now if any body should be inclin'd to make this Experiment after me, he must take care to choose out Duck-weeds that have long Roots, for I never observ'd any of these *Animalcula* in the short Roots of young Weeds, nor indeed in the great Roots, when once they are covered with a rough Matter, and tending to a Decay, as I have seen a great many in the beginning of *August*; neither ought he to leave off his Enquiry, tho he should meet

meet with ten or twenty Roots that have none of the abovementioned Animalcula in them ; for it has happen'd to me that I have examin'd more than five and twenty Roots, without meeting with any of these Animalcula on them ; as also, on the contrary, I have sometimes found three of 'em upon one Weed.

Moreover, in one of my Glasses, in which I had shut up a Weed with its Root, there was an Animalculum of the length of the third part of an Inch, and something thicker than the small Root of the Duck-weed, the Body of which was for the most part Transparent, only there was a Gut or Intestin that ran thro' the whole length of the Body, and was wrinkled or shrivel'd in several places ; and as it came towards the Head it grew rounder and thicker, which I imagin'd to be the Maw or Stomach. This Gut was full of Meat throughout, which the Animalculum had gather'd either from the Roots, or the excrescent Particles round about it ; and forasmuch as the upper part of the Head was provided with a long and pointed Horny substance like a Sturgeon, so also was the Mouth inwards, and joyn'd to the end of the Belly.

The said Gut being fill'd with Meat was in a continual Motion, which I call a pinching or twitching, in order to the attenuation or protrusion of the Chyle ; and if the Guts had not been full of Meat, which hinder'd the Transparency thereof, I should have seen all the Joynts of the Back bone.

The third day, after I had shut up the Animalculum in my Glas, I saw a long and slender little Worm, that I judg'd to be a Thousand times smaller than the aforesaid Animalculum, which had insinuated, or bor'd Part of it self into the Body of the Animalculum, and, as far as it appear'd to me, the Worm labour'd to get in his whole Body ; and the next day in the morning I discover'd that it was in a manner quite got in, and at night I could see nothing of it but a little bit sticking out ; and then I could

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see

see, that in the place where the Worm had insinuated itself, the Animalculum was partly without any Meat, or Motion, whereas there still remain'd some Motion above and below that place : Upon the fifth day after, I saw another Worm trying to get into the Body of the Animalculum, upon which it made a great stir with its Body, and so shook off its Enemy ; and presently after I saw no Motion in the Guts, so that I concluded that the Death of the Animalculum was approaching ; after which it did abandon the Root of the Duck-weed, and placed itself on the side of the Glass, and a little while after I saw it lye dead at the bottom ; from whence I firmly concluded, that the Death of the Animalculum was occasion'd by the Worm's piercing into its Body, whereupon the Guts were so wounded that they were depriv'd off all Motion.

Among several sorts of small Animalcula, I observ'd Three whose Bodies were about as thick as the Hair of ones Head, and Ten times as long.

These Animalcula were so Transparent, that at first I took 'em for nothing but empty Skins ; for one could see nothing but an exceeding small part of it about the Head, and the hinder part of the Body that was not Transparent ; and that part which I judg'd to be the Bowels, was a small part of it inclining to a yellowish colour ; and they had on the fore part of the Head two (as it were) very crooked Claws, and on the hinder part of the Body several Transparent Hairs.

I observ'd these Animalcula several days together, and always saw that they moved their Bodies very nimbly in a Serpentine motion, and as it were in an instant of time, and so removed about from place to place ; and as often as I view'd them, I could never find that they sat still on the Roots of the Duck-weed, or on the sides of the Glass, but were continually roving about in the Water.

Afterwards, when I lookt upon 'em again, I could not perceive the least Motion in their Bodies, either inward or outward, but observed that sometimes they subsided in the Water, and then emerged again, but very leisurely; which appeared very strange to me, because, as I said just now, I could not discover the least motion in their Bodies; tho I don't doubt to Assert, that there is some Motion, be it never so small, in a Body, which in the space of 2 or 3 Pulses shall one while sink to the bottom, and then rise to the top; for it is impossible for us to set an inanimate Body in the Water in such a position, that it shall neither sink quite down, nor emerge quite up to the superficies; and tho we could find a Body (which yet I think is not to be done) that should be just of the same weight with Water, it could not keep the place in the Water to which it was first assign'd; for, according as the Water, into which you put that Body, should encrease or diminish in Heat, that same Water would proportionably take up more or less Space; and consequently the Body, that was so placed that it could neither entirely emerge nor subside, if the Water, for example, should become warmer, and so take up more room, would immediately sink to the bottom. In short, we have reason to be confounded in our imaginations, when we meet with such Animalcula as I before describ'd.

The only Solution therefore that I can give in this case, is, That such an Animalculum has some Air in its Body; and that by squeezing and contracting of its Body it can emit some of the *Materia Subtilis* that is mixt with it, by which it naturally subsides; and on the contrary, by dilating its Body again, an equal quantity of the same *Materia Subtilis* is let in, and so the Animalculum, without stirring itself, shall rise or sink.

Now I was the more easily induced to say what I formerly did about the Animalcula that are fastned to the Roots of Duck-weed; to wit, that they had two distinct

(1790)

revolving Wheels, as they appear'd to others as well as my self ; because I have discover'd several Animalcula that thrust out two Wheels out of the fore part of the Body as they swim, or march on the sides of the Glafs ; one of which I caus'd to be describ'd by Fig. 5. V W X.

This sort of Animalcula I found in great numbers in the Gutter-water in Summer, which had stagnated some days in the small Pits or Cavities of the Lead. These Animalcula are gradually less and less, so far that 50 small ones are not so large as one great one, or full grown Animalculum, that was big with young.

In *Octob.* 1702. I caus'd the Filth or Dirt of the Gutters (when there was no Water there, and the Dirt was quite dry) to be gathered together, and took' about a Tea-cupful of the same, and put it into a Paper upon my Desk ; since which time I have often taken a little thereof and pour'd upon it boyl'd Water after it had stood till it was cold, to the end that I might obviate any objection that should be made, as if there were living Creatures in that Water.

These Animalcula when the Water runs off them, or dries away, contract their Bodies into a Globular or Oval Figure.

After that the abovemention'd Dry substance had lain near 21 months in the Paper, I put into a Glafs Tube of an inch Diameter the remainder of what I had by me, and pour'd upon it boyl'd Rain Water, after it was almost cold, and then immediately view'd the smallest parts of it, particularly that which subsided leisurely to the bottom, and observ'd a great many round Particles, most of which were reddish, and they were certainly Animalcula ; and some hours after I discover'd a few that had open'd or unfolded their Bodies, swimming thro' the Water, and a great many others that had not unfolded themselves were sunk to the bottom, some of which had little holes in their Bodies ; from whence I concluded that the little

Creature call'd the Mite had been in the Paper, and prey'd upon the aforesaid Animalcula.

The next day I saw three particular Animalcula swimming through the Water, the smallest of which was 100 times smaller than the abovesaid Animalcula.

Now ought we not to be astonish'd to find that these small Insects can lye 21 Months dry, and yet live, and as soon as ever they are put into Water fall a swimming, or fastning the hinder parts of their Bodies to the Glass, and then produce their Wheels, as in Fig. 5. W X, just as if they had never wanted Water.

In the month of *Septemb.* I put a great many of the last mention'd Animalcula into a wide Glass Tube, which placed themselves on the sides of the Glass presently, whereupon I pour'd the Water out, and then observ'd that several Animalcula, to the number of 18 or 19, lay by one another in the space of a Course Sand; all which, when there remain'd no more Water, clos'd up themselves in a globular figure.

Some of the Bodies of these Animalcula were so strongly dry'd up, that one could see the wrinkles in them, and they were of a Reddish Colour; a few others were so Transparent, that if you held them up between your Eye and the Light, you might move your Fingers behind 'em, and see the Motion thro their Bodies.

After that these Animalcula had lain thus dry'd up a day or two, I invit'd some Gentlemen to come and partake of the agreeable Spectacle with me; that is, to see how the said Animalcula would divest themselves of their Globular figure, and swim about in the Water.

According to which, after my Friends had satisfy'd their Curiosity, in viewing the Animalcula in their oval or globular form, some of which were so Pellucid as if they had been little Glass Balls, I pour'd some Water into the Glass Tube, whereupon they presently sunk to the bottom; and then the Gentlemen took the said Tube
into

into their Hands, and viewing it one after the other thro a Microscope, they saw the Animalcula after the space of about half an hour beginning to open and extend their Bodies, and getting clear of the Glais, to swim about the Water, excepting only two of the largest of them, that stay'd longer on the sides of the Glais, before they stretcht out their Bodies, and swam away.

When I was by my self, I view'd these Animalcula with a Microscope, after I had pour'd the Water from 'em, in order to see how they brought their Bodies into that Orbicular form as is mention'd above; and having fixt my Eye upon two of the biggest of them, I observed that they did stretch out their Bodies in the space of a minute several times to an extraordinary length, and thrice open'd the hinder part of their Bodies, and discharg'd some Excrements, which, in the little Water that remain'd about them, were dissolv'd into small Pellets, before they assum'd their round figure; and forasmuch as I imagin'd that the Female Animalcula endeavour'd to discharge themselves also of the Burden of their Young, my Observations had lasted longer, but my Eyes being tir'd, I adjourn'd 'em to another time.

In the month of *Octob.* of the last year, before the Dirt and Filth of my Leaden Gutter was quite dry'd up, I took a handful of it, and laid it on a glased Earthen Dish, in order to preserve it; for I don't suffer such foul stuff to lye long in my Gutter, but twice a year cause the Lead to be scower'd so clean that it looks iust like New.

This foul stuff being dry is as hard as Clay; so that the Mites can't come at the Animalcula, that are thus doubly shut up; and now we shall see whether they will live longer than 21 months.

A few days ago I took some of this same dry stuff, and infus'd it both in cold Water that had been boyl'd, and in Rain Water newly fallen; whereupon the Animalcula

(1793)

malcula began to shew themselves, and that in great numbers ; and soon after two sorts of much smaller Animalcula.

In my Letter of the 8th of *Jan.* last, I writ to you about the dreadful Storm that had happen'd the 8th of *Decemb.* before ; and I told you then that the strong Winds had carried the Waves of the Sea over our Meadows and Orchards, from whence I presaged a fruitful year, but few people took notice of my predictions ; however, having discours'd several persons, that concern'd themselves in Tillage or Grazing, upon that subject, they all assur'd me, that they had never known such a plentiful year for Grass, as also for Peas and Beans, as was the last Summer ; and among others, I enquir'd of a Gentleman, that does Fatten *Danish* Oxen every year, about the same : Whose answer was, That he had a piece of Ground on which he fed 26 Oxen, and that if he had turn'd 26 more into the same Pasture, there would have been Grass enough for them ; and that he had never seen so much Grass before ; and that the Oxen were exceeding fat.
